

REMARKS

Claims 1 through 9 have been amended. Claims 1 through 9 remain in the application.

The specification has been objected to by the Examiner. Applicant respectfully traverses this objection.

The specification has been amended to correct the objections. No new matter has been added to the specification. It is respectfully submitted that the specification is allowable.

The drawings were objected to under 37 C.F.R. 1.83(a) because the drawings must show every feature of the invention specified in the claims. Applicant respectfully traverses this objection.

Attached to this Amendment are replacement drawing sheets for the drawings to correct the objections raised by the Examiner. The Examiner should note that the numeration of Figures 4 through 6 has been corrected and that there is no Figure 7. In the replacement sheets, reference numeral 17 for the radiation surface has been added to Figures 2 and 3. Figure 6 of the replacement sheets has been amended to show “a paraboloidal intersecting line on a plane vertically intersecting the lateral surfaces and the LED chip” as required in claim 5. It is respectfully submitted that the replacement drawings are allowable over the objection.

Claim 1 was objected to because on the first line “A light-diode arrangement” should be changed to –light emitting diode arrangement—because all subsequent claims refer to such. Claim 1 was objected because on line 7 there are minor grammatical mistakes. Claim 1 was objected to because on line 13, “its” lacks antecedent basis. Claim 1 was objected to because it was unclear whether the claim is referring to two reflective surfaces of two objects. Claim 9 was objected to because “the space” on line 2 lacks antecedent basis. Applicant respectfully traverses the objections.

Claim 1 has been amended in its title to bring it into conformity with that of the dependent claims. Claim 1 has also been amended to substitute “LED” for “light emitting

diode". Claim 1 has been amended to correct the grammar in line 7 and to provide antecedent basis for the reflector surface of the reflector body. Further, in claim 1 and in some other claims and in the specification, "paraboloidal" has been amended to recite "parabolic". To explain this: "paraboloidal" is the characteristic of a rotational symmetric surface, whereas the claim also is to cover the embodiment of Figure 6 showing a parabolic shape in one section only. If one takes a sheet of paper, one can form a parabolic surface only if one bends the sheet. It is not possible to form a paraboloid therefrom. This embodiment, however, is not rotational symmetric, it does not have paraboloidal surfaces, rather they are parabolic. "Parabolic" is the more general expression. It covers surfaces like that in Figure 5 and also paraboloidal surfaces like in Figure 2. Therefore, "parabolic" has been substituted for "paraboloidal". In claim 3, "paraboloidal" is correct, as it refers to a rotational symmetrical surface. In claim 4, "ferrule" is substituted by "housing", as the description of Figure 4 mentions a housing but not a ferrule. In claim 9, the distinct article before "space" is substituted by the indistinct article, as "space" does not have an antecedent basis in the claim. Therefore, it is respectfully submitted that claims 1 and 9 are allowable over the objections.

Claims 5 and 6 were rejected under 35 U.S.C. § 112, second paragraph, as being indefinite for failing to particularly point out and distinctly claim the subject matter which Applicant regards as the invention. Applicant respectfully traverses this rejection.

Claim 5 has been amended to substitute "paraboloidal" with "parabolic" as the claim refers to the embodiment of Figure 6 in which the reflecting surfaces are not rotational symmetric surfaces but have a parabolic shape in one cross sectional direction only. The same applies to claims 6 and 7. Therefore, it is respectfully submitted that claims 5 and 6 are allowable over the rejection under 35 U.S.C. § 112, second paragraph.

Claim 7 was objected to as being dependent upon a rejected base claim, but would be allowable if rewritten in independent form including all of the limitations of the base claim and any intervening claims.

Counsel for Applicant would like to thank the Examiner for the indication of allowable subject matter. However, claim 1 has been amended and is believed patentable for the subsequent reasons and therefore, since claim 7 depends from claim 1, it too is believed to be allowable.

Claims 1, 2, 4, and 9 were rejected under 35 U.S.C. § 103 as being unpatentable over Kragl (WO 02/054129) in view of Nagatani (U.S. Patent No. 5,799,126). Applicant respectfully traverses this rejection.

WO 02/054129 to Kragl discloses a coupling device for optically coupling an optical waveguide to an electro-optical element. In order to precisely align an optical waveguide (7) in relation to an electro-optical component (2), the electro-optical component is fixed to a submount (1) which can be arranged on any site on a carrier (4). A coupling element (3) comprising a negative image of the contour of the submount (2) is optionally provided for mounting the optical waveguide (7). The coupling element is positively fixed to the submount (2) and the optical waveguide (7) is filled with a transparent adhesive (K).

U.S. Patent No. 5,799,126 to Nagatani discloses a light guide device, light source device, and liquid crystal display device. In the light source device according to the third embodiment using the light guide device 10 according to the first embodiment, a substantial point light source 20, and the incident end surfaces 12 of a plurality of the light guide devices 10 are optically coupled to each other through the opening 26 in the form of a slit, whereby a plurality of light rays of high directivity can exit with high efficiency.

In contradistinction, claim 1, as amended, clarifies the invention claimed as a light emitting diode (LED) arrangement with a reflector, comprising a sub-mount on which a light-emitting diode LED chip is mounted, and a reflector aligned at the sub-mount. The sub-mount comprises a reflector surface located in a beam path of the LED chip, wherein the sub-mount comprises a blind hole into which the LED chip is inserted and which comprises a parabolic reflector surface disposed above the blind hole. The reflector surface has a focal point in which a

center of a surface of the LED chip is located. The reflector is formed by a solid body formed of a transparent material and comprising a small irradiation surface opposing the LED chip and a large radiation surface opposing same at a distance, between which a lateral surface forming a parabolic reflector surface extends. The sub-mount comprises an opening above the blind hole into which the reflector body is inserted with the irradiation surface first so that its reflector surface forms a continuation of the reflector surface of the sub-mount.

The United States Court of Appeals for the Federal Circuit (CAFC) has stated in determining the propriety of a rejection under 35 U.S.C. § 103, it is well settled that the obviousness of an invention cannot be established by combining the teachings of the prior art absent some teaching, suggestion or incentive supporting the combination. See In re Fine, 837 F.2d 1071, 5 U.S.P.Q.2d 1596 (Fed. Cir. 1988); Ashland Oil, Inc. v. Delta Resins & Refractories, Inc., 776 F.2d 281, 227 U.S.P.Q. 657 (Fed. Cir. 1985); ACS Hospital Systems, Inc. v. Montefiore Hospital, 732 F.2d 1572, 221 U.S.P.Q. 929 (Fed. Cir. 1984). The law followed by our court of review and the Board of Patent Appeals and Interferences is that “[a] prima facie case of obviousness is established when the teachings from the prior art itself would appear to have suggested the claimed subject matter to a person of ordinary skill in the art.” In re Rinehart, 531 F.2d 1048, 1051, 189 U.S.P.Q. 143, 147 (C.C.P.A. 1976). See also In re Lalu, 747 F.2d 703, 705, 223 U.S.P.Q. 1257, 1258 (Fed. Cir. 1984) (“In determining whether a case of prima facie obviousness exists, it is necessary to ascertain whether the prior art teachings would appear to be sufficient to one of ordinary skill in the art to suggest making the claimed substitution or other modification.”)

As is disclosed in the opening portion of the specification, it is the aim of the present invention to improve the efficiency of a light emitting diode (LED) arrangement. Efficiency in this context means that most of the light emitted by the LED is bundled (or collimated) in a single direction. This can physically be attained only by redirecting the largest possible amount of the light emitted by the LED into the single direction.

It is well known that redirecting of light rays may be made either by metallic reflection (at metallic reflecting faces) or by refraction (at interfaces between media of different optical characteristics, like glass and air, or glasses of different properties). Refraction may also result in reflection if the Brewster angle of incidence is not surpassed. The present invention exclusively uses reflection, however, reflection of different types, namely reflection at metallic mirror faces and reflection by refraction at an interface between a solid body and surrounding air.

In order to improve the efficiency of light redirection by reflection, there is no other way but arranging reflecting surfaces in the path of light rays not propagating in the desired direction. In practice, this aim results in an increase of the surface area of reflecting surfaces.

None of the references cited, either alone or in combination with each other, teaches or suggests the claimed invention of claims 1 through 9. Specifically, Kragl '129 merely discloses a coupling device for optically coupling an optical waveguide to an electro-optical element. In the arrangement of Kragl '129, there is only one reflecting surface which is effective in redirecting light rays in a desired single direction, i.e. in a direction normal to the LED. This single reflecting surface is formed by the sub-mount 1 in the embodiment of Figure 4. The circumferential surface of the polymer optical fibre (POF) is a reflecting surface as well. However, this surface has no characteristics in the sense of a bundling or focusing of light rays. Rather, the light rays leave the POF in the same irregularity as that in which they enter the POF, as the angle of incidence of a light ray at the circumferential surface of the POF is the same as the angle of exit of the light ray from the reflection point, and the circumferential wall is cylindrical. This is confirmed by U.S. Patent No. 5,727,108 to Hed, Column 2, Lines 42 through 44.

If one wanted to increase the reflecting surface of the Kragl '129 device, the reflecting surface of the sub-mount would have to be extended in the axial direction of the paraboloidal reflecting metal surface. Thus, the sub-mount would become "high" thereby,

rendering manufacture of the sub-mount, the mounting of the LED in its blind hole and the electric connection thereto by bond wires complicated.

One could think of stacking a paraboloidal hollow mirror which extends the reflecting surface of the sub-mount onto the sub-mount. This idea, which is not shown by the prior art, is not taken over by the present invention. Rather, the present invention provides that the reflecting surface of the sub-mount is axially extended by the circumferential surface of a separate, solid transparent body which is inserted into the opening delimited by the paraboloidal reflecting surface of the sub-mount.

The solid body is not a POF (of which the entrance surface has the same size and shape as its exit surface), but is a body having a small irradiation (i.e. entrance) surface opposing the LED and a large radiation (exit) surface opposite thereto at a distance. The circumferential surface of the body connecting the irradiation and the radiation surfaces is a surface which reflects by refraction, as the Brewster angle of incidence of the light rays, propagating in the solid body is not exceeded, the ambient environment of the solid body being air. The reflecting surface of the solid body is not a metallic surface of reflection, but forms a continuation of the metallic reflecting surface of the sub-mount.

The aim of the present invention to improve the bundling of the light rays is attained only if the reflecting surface of the solid body has a bundling or beam forming effect (which can never be fulfilled by a POF). It is implied thereby that the reflecting surface of the solid body is parabolic as the reflecting surface of the sub-mount is, with the same geometric parameters as the reflecting surface of the sub-mount. Otherwise, one could not speak of “a continuation of the reflector surface of the sub-mount” as claim 1 does.

Thus, the present invention provides a parabolic reflecting surface which is formed by two portions: a first one which is a metallic reflector surface formed by the sub-mount, and a second one which is an internal surface of total reflection at an interface between a transparent solid body and ambient air.

It is an important benefit of the present invention that manufacture of the arrangement is made rather easy. The sub-mount may, be manufactured in the usual way, the solid body may be manufactured by turning (if it is rotational symmetric, which is preferred) and cutting from a rod material, and the assembly of both is simplified by the fact that the solid body auto-adjusts centrally within the opening of the sub-mount.

None of the references shows this concept. Kragl '129 deals with the irradiation of a POF only. There is no bundling (or collimating) effect outside the sub-mount. The POF radiates light in the same non-directed manner at its output surface as it receives it at the irradiation (=input) surface.

Nagatani '126 merely discloses a light guide device, light source device, and liquid crystal display device, of which it can emit light rays at high directivity with high efficiency irrespective of incident angles. However, as may be seen from Figure 4 of Nagatani '126, the light source 20 comprised in housing 22 itself does not have any light directing properties. There is no mirror within the housing which has any kind of bundling effect. The only light directing element is the transparent light guide device 10 which principally has a frustoconical shape having a small entrance face and a larger exit face. Its cross section is essentially circular at all length portions as shown in Figure 1A or is polygonal at one of its end portions as is shown in Figures 2A and 2B. As is shown in Figure 1B, the directivity effect of the transparent body is poor, resulting from the fact that the body is frustoconical but not paraboloidal.

Nagatani '126 neither suggests to shape the reflecting surface paraboloidal nor suggests to make the reflecting surface of the transparent body the continuation of a basis mounting the light source. In Nagatani '126, the light source is a point light source, e.g. a metal halide lamp housed in a reflection box having the inside wall covered with silver reflecting surface. It is clear therefrom that it is impossible that the reflecting surface of the transparent body is a continuation of the reflecting surface of the reflection box within the context of the

present invention. According to Nagatani '126, a light box having a silver reflecting surface in combination with a transparent body having a frustoconical reflecting surface are sufficient to fulfill the task posed to the Nagatani device. Therefore, one skilled in the art would never take the transparent body of Nagatani '126, provide same with a paraboloidal surface and combine it with a sub-mount of Kragl '129. As such, there is no suggestion or motivation for combining Kragl '129 and Nagatani '126 together and such a combination is not obvious.

The references, if combinable, fail to teach or suggest the combination of a light emitting diode (LED) arrangement with a reflector, comprising a sub-mount on which a light-emitting diode LED chip is mounted, and a reflector aligned at the sub-mount, the sub-mount comprising a reflector surface located in a beam path of the LED chip, wherein the sub-mount comprises a blind hole into which the LED chip is inserted and which comprises a parabolic reflector surface disposed above the blind hole, the reflector surface having a focal point in which a center of a surface of the LED chip is located, the reflector being formed by a solid body formed of a transparent material and comprising a small irradiation surface opposing the LED chip and a large radiation surface opposing same at a distance, between which a lateral surface forming a parabolic reflector surface extends, and the sub-mount comprising an opening above the blind hole into which the reflector body is inserted with the irradiation surface first so that its reflector surface forms a continuation of the reflector surface of the sub-mount as claimed by Applicant.

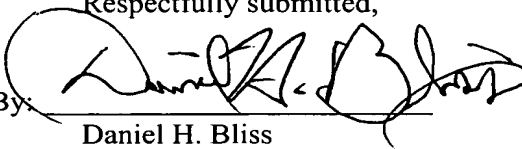
Further, the CAFC has held that "[t]he mere fact that prior art could be so modified would not have made the modification obvious unless the prior art suggested the desirability of the modification". In re Gordon, 733 F.2d 900, 902, 221 U.S.P.Q. 1125, 1127 (Fed. Cir. 1984). The Examiner has failed to show how the prior art suggested the desirability of modification to achieve Applicant's invention. Thus, the Examiner has failed to establish a case of prima facie obviousness. Therefore, it is respectfully submitted that claim 1 and the claims dependent therefrom are allowable over the rejection under 35 U.S.C. § 103.

Claims 3, 5, and 6 were rejected under 35 U.S.C. § 103 as being unpatentable over Kragl '129 and Nagatani '126 and further in view of Hed (U.S. Patent No. 5,727,108). Applicant respectfully traverses this rejection for the same reasons given above to independent claim 1.

Claim 8 was rejected under 35 U.S.C. § 103 as being unpatentable over Kragl '129 and Nagatani '126 and further in view of Clarke (U.S. Patent No. 4,915,479). Applicant respectfully traverses this rejection for the same reasons given above to independent claim 1.

Obviousness under § 103 is a legal conclusion based on factual evidence (In re Fine, 837 F.2d 1071, 1073, 5 U.S.P.Q.2d 1596, 1598 (Fed. Cir. 1988), and the subjective opinion of the Examiner as to what is or is not obvious, without evidence in support thereof, does not suffice. Since the Examiner has not provided a sufficient factual basis, which is supportive of his/her position (see In re Warner, 379 F.2d 1011, 1017, 154 U.S.P.Q. 173, 178 (C.C.P.A. 1967), cert. denied, 389 U.S. 1057 (1968)), the rejections of claims 1 through 6, 8, and 9 are improper. Therefore, it is respectfully submitted that claims 1 through 6, 8, and 9 are allowable over the rejections under 35 U.S.C. § 103.

Based on the above, it is respectfully submitted that the claims are in a condition for allowance, which allowance is solicited.

Respectfully submitted,

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